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A Network Analysis of the Economic Development Community of Ethiopia Part 2

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October 2012

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As part of an effort to create a network analysis "tool kit," our team compared and contrasted two networks of the Ethiopian economic development community. The purpose of this initial analytical effort is to develop the capability to classify and identify influential nodes in a network model. The team developed an initial model collected through open data sources and then, based on feedback from the US Embassy in Addis Ababa revised the model. This paper details the analysis of these two network models. An elaboration of the original data collection methods and analysis can be found in the *A Network Analysis of the Economic Development Community of Ethiopia (Johnson, Kewley, Evans, 2012)* recently published in the Defense Technical Information Center (www.dtic.mil).

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October 2012

A Network Analysis of the Economic Development Community of Ethiopia Part 2

Lauren Kewley, and Daniel Evans

Background

As part of an effort to create a network analysis "tool kit," our team developed a network of the Ethiopian economic development community, as viewed from the standpoint of a firm interested entering the market. The purpose of this initial analytical effort is to develop the capability to classify and identify influential nodes in a network model.

The original dataset was collected through open data sources using a top-down approach beginning with the major political leaders. This method proved to be effective as the Ethiopian economic development environment is largely influenced by the government (U.S. Department of State, 2012). An elaboration of the original data collection methods and analysis can be found in the *A Network Analysis of the Economic Development Community of Ethiopia (Johnson, Kewley, Evans, 2012)* recently published in the Defense Technical Information Center (www.dtic.mil).

Once the key individuals and organizations had been identified using network analysis, the project was briefed at the U.S. Embassy in Ethiopia. The Embassy staff confirmed the accuracy of most of our findings. and provided excellent feedback and additional information that had not been readily available through the sources used to compile the original data set. This included the names of several influential private companies, agencies, and banks. We also learned that relationships forged during the Ethiopian Revolution are a major influence in current Ethiopian politics and economic development. They suggested that gathering information about who fought together during the war would supply additional relationship information and enable the team to develop a more complete model. Also, during the original data collection phase, we overlooked the Ethiopian Chamber of Commerce and MIDROC (http://www.midroc-ethiopia.com.et/), an influential private investment group. The Embassy staff suggested that these organizations be added to the initial model because, based on their expertise, these organizations were influential in the community.

Analysis

The team then refined the original data set by including these organizations and the agents associated with them. Again, the team turned to open data sources to learn more about these entities. Unfortunately, the amount of information available regarding these new agents and their associated organizations was limited. The team believes that this can potentially be remedied by contacting other sources, such as the Embassy staff or other people with local knowledge, to fill in the informational gaps. Despite these gaps, the modified network is more accurate, allowing for an analysis that provides insight into Ethiopia's economic development environment.

Agent Network

Once the additional information was gathered and appended to the original data set, a new network model was developed. The team first developed an agent network, which, as described in the initial paper, is a network of individuals linked by their connections to various organizations, events, and locations. We then examined the changes in node level centrality measures and interestingly, some of the agents that were added to the original data set were identified as influential nodes. These individuals are shown in Table 1 which addresses four major centrality measures: betweenness, closeness, eigenvector and degree.

Rank	Degree	Betweenness	Closeness	Eigenvector
1	Sufian Ahmed	Ayalew Zegeye	Abay Tsehaye	Sufian Ahmed
2	Girma Birru	Abdulfetah Abdulahi Hassan	Meles Zenawi	Girma Birru
3	Berhanu Getaneh	Abdi Mohamed Omar	Girma Birru	Meles Zenawi
4	Meles Zenawi	Girma Birru	Sufian Ahmed	Abay Tsehaye
5	Tsehay Shiferaw	Abay Tsehaye	Mesenbet Shenkute	Kuma Demesska

Table 1. A table listing the people ranking in the top five in terms of the four major centrality measures considered in the updated network of the Ethiopian economic environment. Individuals who are new to the data set are shaded.

Degree centrality is simply a measure of a node's importance based on the number connections a node has. If a node has one of the highest degree centralities, then it has the most connections in the network (Wasserman and Faust, 178). Betweenness

centrality is a measure of a node's "interpersonal influence." It shows how often a node lies between two other nodes along their geodesic or shortest path (Wasserman and Faust, 1994). Closeness centrality is a measure of how near or far a node is to all other nodes in the network based on its shortest paths to each node. A node with high closeness centrality can quickly access the other nodes (Wasserman and Faust, 1994). Finally, eigenvector centrality measures a node's importance by examining that node's connectedness to other influential nodes in the network. Being connected to an influential node will increase a node's own influence and therefore its eigenvector centrality (Newman, 2008). Table 1 shows the top five individuals for each of these measures in the social network.

Of the eleven names that appear in Table 1, seven did not appear in the top-five list for the original network. Betweenness centrality is of particular interest, as four people of the top five are new. This change can be explained by examining the new network as a whole. The network is pictured in Figure 1 below.

Modified Agent Network Sized by Betweenness

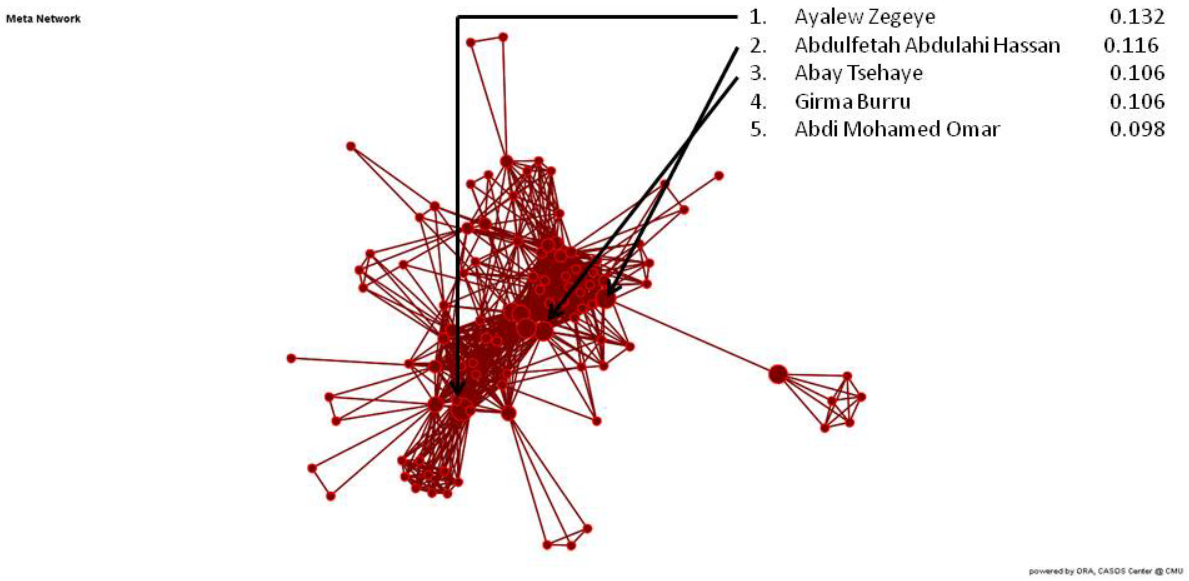


Figure 1. The social network generated using the updated data set. Nodes are sized by betweenness, and the top five agents are listed along with their betweenness measures.

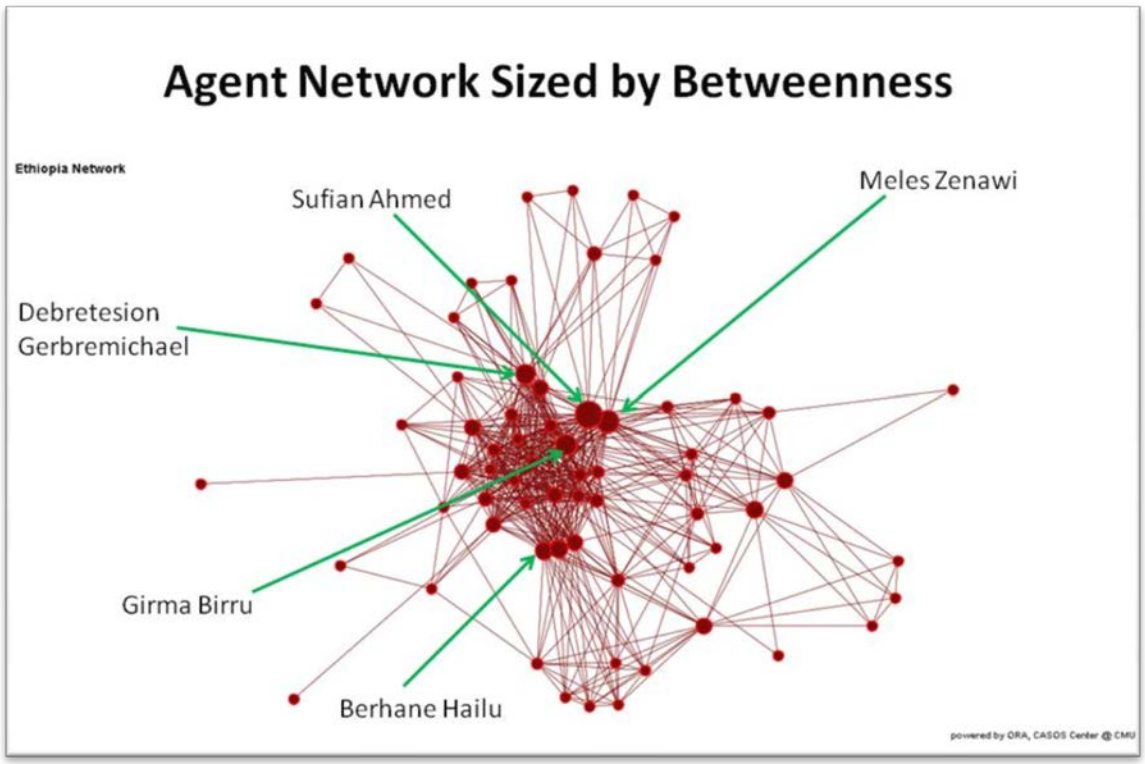


Figure 2. The social network generated using the original data set. Nodes are sized by betweenness, and the top five agents are listed along with their betweenness measures.

The network illustrated in Figure 1 displays greater community structure than that of Figure 2. That is, there are subgroups, or "communities," that are very well-connected internally but have fewer links to the rest of the network. As a result, there exist several "community bridges" which connect a community to the rest of the network (Newman, 2004). By definition, these community bridges are intermediaries within the network. The new information incorporated in the network fostered greater community structure, and in turn created new intermediaries. As a result, we see new nodes with high betweenness centrality.

Another way to visually represent the network in terms of centrality measures is a two-dimensional scatter plot. In Figure 3 we plotted betweenness centrality vs. eigenvector centrality. Doing so provides additional information about the individuals because the two measures mathematically represent unrelated node characteristics. This figure illustrates a number of "noteworthy" nodes, which we define to be agents with centrality measures greater than two standard deviations above the mean. There are only a few

agents with eigenvector centrality measures greater than two standard deviations from the mean.

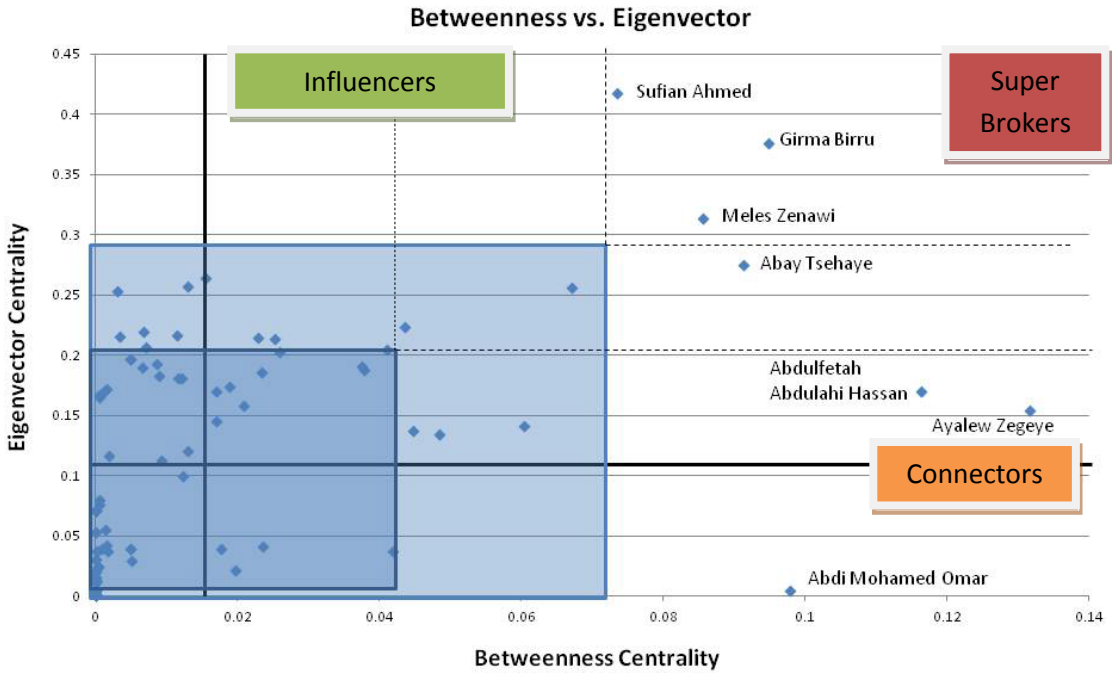


Figure 3. Scatter plot of betweenness centrality vs. eigenvector centrality for agents within the Ethiopia social network. The plot is divided into quadrants by lines representing the mean values of betweenness and eigenvector centrality. The blue regions represent ±1 and ±2 standard deviations from the mean. Nodes outside of these regions are labeled for clarity.

In Figure 3, the nodes located in the top right corner are of particular interest because they have both betweenness and eigenvector centrality measures that are greater than two standard deviations from the mean. These influential nodes will be referred to as *Super Brokers* (note: the team has modified node role titles since the original paper). The three agents we classify as brokers are Sufian Ahmed, Girma Birru and Meles Zenawi. These individuals were all present in the original network and had already been identified as key actors. The addition of more information to the data set did not affect their importance in the network. This observation strengthened the conclusion that these are three of the most important people in the network.

Four other agents exhibited betweenness centrality measures greater than two standard deviations from the mean. All of them were new additions to the network. In Figure 3 these individuals are labeled as *Connectors*. This is because they often connect communities to the rest of the network.

First, consider Abay Tsehaye, a new addition to the network model. Table 1 illustrates that Abay Tsehaye appeared in the top five of betweenness, closeness and eigenvector centrality measures. As the Minister of Federal Affairs of Ethiopia he maintains power over the administration of the Ethiopian capital, Addis Ababa. However, perhaps his biggest role is as one of the seven founding members of the Tigray People's Liberation Front (TPLF). During the Ethiopian Revolution, it was the TPLF that seized power from a military dictator in the early 1990's and has maintained control of the Ethiopian government ever since. As a member of the TPLF central committee, Mr. Abay is directly connected the most influential political party as well as to Prime Minister Meles Zenawi who is also a member of the central committee (Tareke, 2009). Combining this real-world context with the centrality calculations demonstrates that Abay Tsehaye is undoubtedly an influential agent in this Ethiopian economic development network.

Another addition to the model is Ayalew Zegeye. Figure 3 illustrates that he has the highest betweenness centrality measure, but also that his eigenvector centrality measure is above the mean but still within one standard deviation. Mr. Ayalew is an example of a previously discussed *Connector*. In Figure 1, he is indicated by an arrow and at this location in the network we see a bottlenecking effect. This occurs because he is one of the few members of a given community with a direct connection to the rest of the network. Again, this individual's social standing reinforces the conclusion that he is influential. Ayalew Zegeye is the president of the Addis Ababa Chamber of Commerce and Sectoral Associations (AACCSA). This organization would be of great interest to a business looking to enter the Ethiopian economy because it is likely influential in assisting or hindering the success of a new business. As the capital of Ethiopia, Addis Ababa is the central hub for all business activity in the country. Therefore, despite being active in only one city, the AACCSA is very influential. Following that logic, Ayalew Zegeye is an influential agent in the network.

There are two other people in the network who play a similar role to Ayalew Zegeye. Abdulfetah Abdulahi Hassan and Abdi Mohamed Omar also bridge communities. Interestingly, they are both members of the Somali Regional State government, and therefore connect the easternmost region of Ethiopia to the rest of the country. It is important to note that the Somali region of Ethiopia is entirely separate from the nation of Somalia. Examining Figure 3 illustrates that Abdulfetah Abdulahi Hassan is similar to Ayalew Zegeye in that he has a high betweenness centrality but remains within one standard deviation from the mean in eigenvector centrality. As the Minister of Labor and Social Affairs as well as an active member of the House of People's

Representatives and the Somali People's Democratic Party (SPDP), Mr. Abdulfetah plays a role in a variety of political organizations.

Returning to Figure 3, we see that while Abdi Mohamed Omar maintains a high betweenness centrality, he has one of the lowest eigenvector centrality measures in the network. These calculations are interesting because Abdi Mohamed Omar is President of the Somali Region of Ethiopia. However, the low eigenvector value might be the result of a few situations. For instance, this could be a circumstance in which the president does not actually wield much influence. While in Ethiopia, the team learned that this is not unheard of in Ethiopian state administrations.

Finally, Table 1 drew attention to three other new names because of their high centrality measures: Mesenbet Shenkute, Berhanu Getaneh and Tsehay Shiferaw. We know that they all appear in the top five for at least one of the four major centrality measures. The table below indicates each of these individual's rank for those centrality measures as well as if the corresponding measure exceeded ±1 or ±2 standard deviations from the mean.

Name	Degree Rank	Betweenness Rank	Eigenvector Rank	Closeness Rank
Mesenbet Shenkute	39	10	41	5
Berhanu Getaneh	3	8	7	38
Tsehay Shiferaw	5	29	6	41

≥ +1 Standard Deviation

≥ +2 Standard Deviations

Table 2. Table of rank of four major centrality measures of new names from Table 1. Yellow indicates that the corresponding measure is greater than 1 Standard Deviation from the mean and orange indicates that it is greater than 2 Standard Deviations from the mean. No color indicates that the corresponding measure is less than 1 Standard Deviation from the mean.

Mesenbet Shenkute is high in both betweenness and closeness centrality. Berhanu Getaneh and Tsehay Shiferaw both have high eigenvector and degree centrality. The fact that both of these degree centrality measures are greater than two standard deviations from the mean is worthy of attention. Since they are directly connected to a large number of other people in the social network, they are capable of disseminating

information effectively. All three of the individuals listed in Table 2 are presidents of private commercial banks. Mesenbet Shenkute is President of the Abay Bank, Berhanu Getaneh is President of the United Bank and Tsehay Shiferaw is President of the Awash Bank.

Organization Network

In addition to the Agent Network, we also considered the single-mode organization network. Beginning with a multi-modal network of organizations and people, organizations were linked to one another through their connections to people. The result is the single-mode organization network. For example, Meles Zenawi is connected to both the Council of Ministers and the Tigray People's Liberation Front (TPLF). Therefore, in the organization network, the Council of Ministers and the TPLF share a connection. The figure below is an illustration of the organization network.

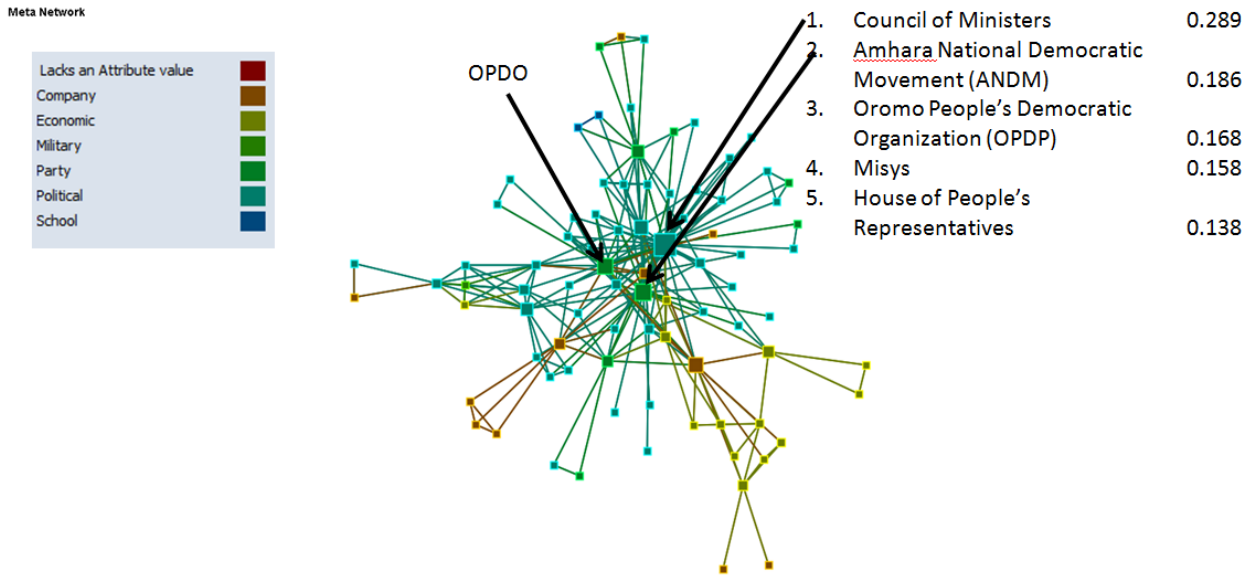


Figure 4. Organization by organization network built from updated Ethiopia data set. Nodes are sized by betweenness and colored by the attribute, sector. The included legend is provided to identify each node's sector and the nodes with the five highest betweenness measures are listed.

Table 3 demonstrates that the only change in the top five for betweenness centrality from the original network was the replacement of the Ethiopian Electric Power Company with Misys. With the fourth highest measure of betweenness, Misys appears to be a significant intermediary. According to the firm's web site (www.misys.com), Misys is a privately-held British multinational software company. The firm specializes in software for banking and investment businesses, including ATM services for the Commercial

Bank of Ethiopia, the Awash Bank, the National Bank of Ethiopia and the Construction and Business Bank. The team then analyzed Misys' other centrality measures.

Rank (Betweenness)	Original Organization Network	Updated Organization Network
1	Council of Ministers	Council of Ministers
2	Amhara National Democratic Movement	Amhara National Democratic Movement
3	Oromo People's Democratic Organization	Oromo People's Democratic Organization
4	Ethiopian Electric Power Company	Misys
5	House of People's Representatives	House of People's Representatives

Table 3. Table comparing the organizations with the five highest betweenness centrality measures in the original network to the top five in the updated network.

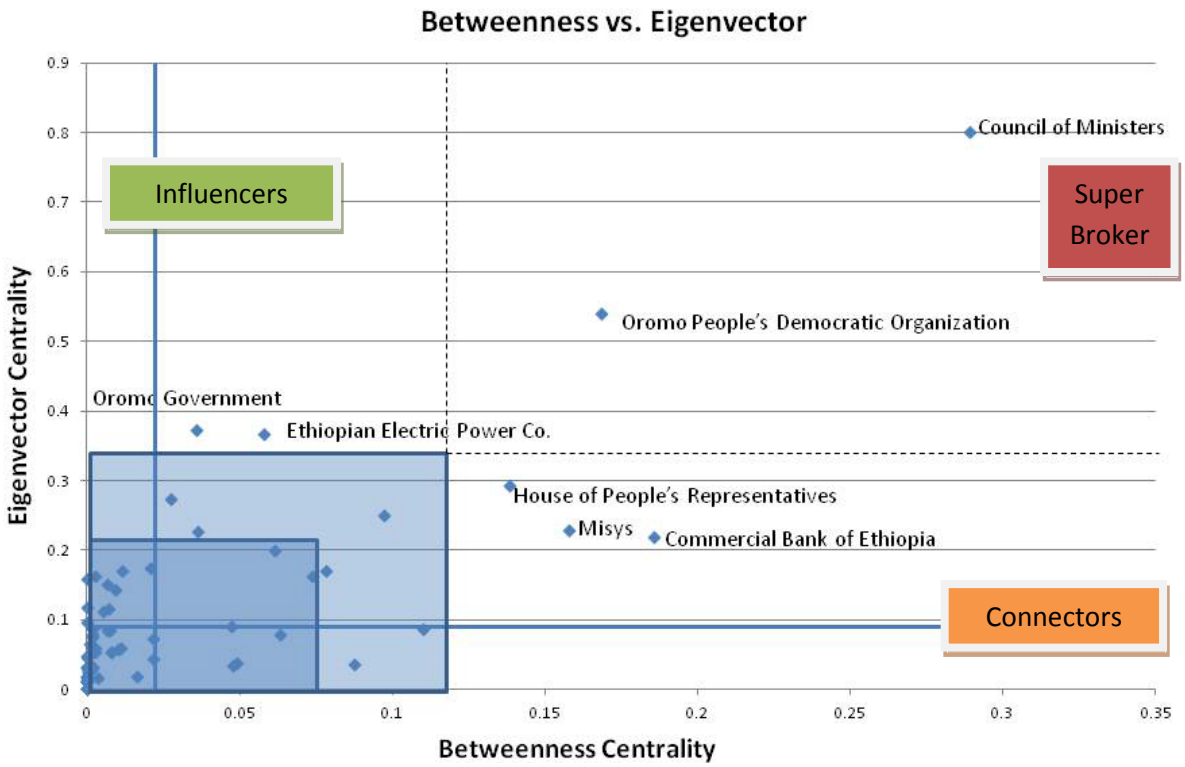
There are a total of eighty-four organizations in the network, and since Misys ranks high in all four major centrality measures, it appears that Misys is influential. Interestingly, Figure 4 illustrates that the majority of the important organizations are political, to include political parties. Commercial companies do not appear to have a large impact. Also, it should be noted that many of the commercial firms in Ethiopia are either government-owned, or the government owns a large stake in the businesses. The team hypothesizes that Misys appears to be influential because of the common software platform shared by influential banks. This insight requires further investigation but if a business desires an introduction to key members of the commercial bank network, it might be beneficial to approach them by utilizing Misys as an intermediary.

Measure	Degree	Betweenness	Eigenvector	Closeness
Rank	3	4	10	2

Table 4. Table of Misys' rank in the four major centrality measures.

A two dimensional plot of betweenness vs. eigenvector provides insight into the positions of the nodes within the organization network. Using the same conventions as we did for the Agent Network, we plotted the two centralities in Figure 4 against each other and used the results to identify key organizations and their roles.

The only organizations with a betweenness or eigenvector centrality values greater than two standard deviations from the mean are The Council of Ministers and the Oromo People's Democratic Movement. Misys, which has already been discussed, is the only addition to the model described in the initial paper and is characterized as a *Connector*.



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Conclusion

Thus far we have discussed changes in influential individuals and organizations due to the incorporation of new data. However, note that some important nodes in the original network remained important in the modified network. This is best seen by referring to Table 4 which contains two tables comparing the roles of notable agents and organizations in both networks. Sufian Ahmed and Girma Birru remained *Super Brokers* in the Agent Network. In the Organization Network, the Council of Ministers

and the Oromo People's Democratic Organization (OPDO) remained *Super Brokers*. While the roles of these entities from the original network remained constant, some entities changed roles. For example, Meles Zenawi changes from being a *Connector* to a *Super Broker* and the Ethiopian Electric Power Company (EEPCo) went from being a *Connector* to an *Influencer*.

Central Nodes: Original Network			
	Super Brokers	**Connectors**	**Influencers**
Individuals	Girma Birru	Meles Zenawi	Kuma Demesska
	Sufian Ahmed	Debretsion Gerbremichael	
Organizations	Council of Ministers	ANDM	
	OPDO	EEPCo	
		SEPDM	
		House of People's Representatives	

Central Nodes: Updated Network			
	Super Brokers	**Connectors**	**Influencers**
Individuals	Sufian Ahmed	Abay Tsehaye	
	Girma Birru	Ayalew Zegeye	
	Meles Zenawi	Abdulfetah Abdulahi Hassan	
		Abdi Mohamed Omar	
Organizations	Council of Ministers	House of People's Representatives	Oromo Government
	Oromo People's Democratic Movement	Misys	Ethiopian Electric Power Corporation (EEPCo)
		Commercial Bank of Ehtiopia	

Table 4. Comparison of influential nodes in network after modifying network

We examined the set of new nodes which have been discussed in this paper and in doing so were able to see that they were from several different sectors of the economic environment. This diversity reinforces our conclusions because it suggests that the network model was not influenced due to oversampling a particular sector. Since we

cannot easily classify the new influential nodes into a single category, it is not likely that our conclusions are a result of a large sampling bias.

By refining the data set, it is possible to identify influential nodes which the previous analysis might have overlooked. However, gaps in the information are a problem in network analysis because it is impossible to analyze information that is not available. This is the reason that the list of important nodes is not a guarantee but rather an informed conclusion based on the information provided.

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Addis Ababa Chamber of Commerce and Sectoral Associations is a site that lists influential members of the Ethiopian economic community. http://www.addischamber.com.

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